

Tata Steel technical Directive

R2650401 Cast – Resin Transformers

This guideline is under management of:

A.L. Keet; tel. 0031 6 51170499; e-mail: at.keet@tatasteelurope.com

D.M.G. Kramer; tel. 0031 6 46214400 e-mail: dennis.kramer@tatasteelurope.com

S. Vink tel. 0031 6 31133233 email sander.vink@tatasteelurope.com

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1 Introduction

1.1. Guideline description

History of the Guide line:

- Version 2.0 from Feb 2006 to April 2019 (publish on the Intranet of Corus)
- Version 3.0 up to 3.7 from April 2019 up to march 2021 (internal used in Tata Steel PTC EIC)
- Version 4.0 from November 2022 (publish on the intranet of Tata Steel).

This document (R2650401) defines the general technical requirements for the delivery of cast resin power transformers at Tata Steel IJmuiden, the guideline existed of two parts:

- The fixed technical requirements (guideline R2650401)
 - The specific technical requirements concerning each transformers (separate document). For each transformer there will be a separate Data Sheet (A, B, C etc.)
- The extra requirements in this document is binding above the general guideline.

The guideline is for delivery of cast resin power transformers the basic design is for distribution transforms. For drive and special transformers other specification can be asked like vector group, extra phase shift and/or secondary voltage.

For all type of transformers for Tata Steel the ECO design directive is mandatory, there is NO exception for special transformers (for example drive transformers)

1.1.1. Project philosophy

A successful project is based on:

1. Safety; Safe operation and optimized working conditions for our operators, maintenance people and visitors;
2. Quality; The machinery delivered and installed meets high quality industrial standards and is able to process high quality products for our customers;
3. Reliability; A reliable system is a result of a proven design in the market.

It is the intention of TATA STEEL to aim for standard and proven solutions and to make use of the expertise of the CONTRACTOR with recently built systems and to benefit from the CONTRACTOR's standard solutions.

The CONTRACTOR is invited to propose and specify the systems and solutions that, to his opinion, will give the best fit to the objectives and requirements, taking into consideration today's common standards for safety, working conditions, reliability, performance and economics.

1.2. Communication

In Data Sheet you will find the persons concerning this project.

1.2.1. Language

For this project communication language will be as follows:

- Project language for communication English
- Labels on buttons etc. Dutch
- Operating manual Dutch
- Maintenance manual Dutch/English
- Technical Construction File English
- Engineering English

2. Standards and directives

Transformers and accessories must be in accordance with the latest edition of Dutch, European and international standards and regulations, including any amendments.

The following referenced documents, not the complete list, are indispensable for the application of this document.

Standards

NEN-EN-IEC 60076	Power transformers (NEN-EN-IEC 60076-11, 2018)
NEN 10616	Power transformers - Terminal and tapping markings
NEN-EN-IEC 61378-1	Convertor transformers - Part 1: Transformers for industrial applications
NEN-EN-IEC 60529	Degrees of protection provided by enclosures
NEN 1010	Electrical installations for low-voltage - Dutch implementation of the HD-IEC 60364-series
NEN-EN 50160	Voltage characteristics of electricity supplied by public electricity networks
EN 50588-1	General requirements

Directives

Low Voltage Directive 2006/95/EC

EMC Directive 2014/30/EU

Eco Design Power Transformers Directive 2009/125/EC:

For all type of transformers for Tata Steel the ECO design directive is mandatory, there is NO exception for special transformers (for example drive transformers) so table I.2 and I.5 are valid for all cast resin transformers. (note, delivery after 1 July 2021 lower losses according phase two is mandatory)

If Losses are lower than the ECO design described this will be a preferent item in the selection.

3. General conditions

3.1. Environmental

Ambient temperatures between -5 °C and +35 °C,
Altitude 0 – <1000 m
Installation indoors.

3.2. Supplied voltages

System voltage : 3,15 , 6,3 , 10,5 kV see Data Sheet
Voltage fluctuations : -15 % and +5 %
System grounding : insulated
System frequency : 50 Hz
Power Quality : see **option A** or **option B**

Option A

Harmonic voltages at full load for transformers with distribution applications according to NEN-EN 50160 values, with a total harmonic distortion of 8 %.

Option B

Harmonic currents at full load for transformers with convertor applications according to the table below. Load and no load losses must be calculated and specified during bidding phase.

Harmonic. Order nr	% of In		Harmonic. Order nr	% of In
5	20.0		53	0.5
7	14.1		55	0.5
11	9.1		59	0.5
13	7.7		61	0.5
17	5.9		65	0.5
19	5.3		67	0.5
23	4.3		71	0.5
25	4.0		73	0.5
29	3.4		77	0.5
31	3.2		79	0.5
35	2.9		83	0.5
37	2.7		85	0.5
41	2.4		89	0.5
43	2.3		91	0.5
47	2.1		95	0.5
49	2.0		97	0.5

4. General requirements

4.1. Diverse

- ☐ Three-phase transformer, vector group Dyn5
- ☐ Climatic class code C1
- ☐ Environmental class code E4 (= E2 from 2004)
- ☐ Fire behaviour class code F1
- ☐ Seismic class no demands accept for crane application (S-I)
- ☐ Insulation system thermal class code F, 100 K at rated current (included the applicable harmonic currents
- ☐ Guaranteed weighed sound pressure level Lp at 1 meter see data sheet paragraph 1.3
- ☐ Transformer losses according to Directive 2009/125/EC
- ☐ **Partial discharge max 1 pC above background level and < 5 pC**
- ☐ Insulation levels according to NEN-EN-IEC 60076-11 (table 3, list 2), For all operation voltage a one level of um is predetermined see table 1
Values in the table are also in accordance with NEN-EN-IEC 61936-1:2020.

Operating voltage (Principal voltage)	Highest Voltage for equipment Um	Minimum phase to earth and phase to phase clearance	Rated short duration separate source AC withstand voltage	Rated lightning impulse withstand voltage
420 V 525 V 725 V	3,6 kV	60 mm	10 kV	20 kV
< 1.600 V	3.6 kV	60 mm	10 kV	40 kV
3.150 V	7.2 kV	90 mm	20 kV	60 kV
6.300 V	12.0 kV	120 mm	28 kV	75 kV
10.500 V	17,5 kV	160 mm	38 kV	95 kV

Table 1: Um, Clearance, AC Duration and Lightning Impulse withstand voltages

4.2. Windings and terminals

Windings can be made of copper or aluminium.

High voltage windings shall be glass fibre reinforced, void free:

- ☐ full vacuum cast resin insulated.
- ☐ cast coil cast resin insulated.

The low voltage windings shall be:

- ☐ glass fibre reinforced, void free, full vacuum cast resin insulated, or
- ☐ glass fibre reinforced cast resin insulated or pre-impregnated, with the edges (top and bottom) enclosed with resin and bound by a heating process to a strong cylinder.

Winding end terminals, including neutrals, preferred to be made of copper or if it is Aluminium a CUPAL plate (no rings) must be delivered.

Dimension of the LV terminal is depending of the number of cable so see the note in the Data Sheet.

4.3. Mechanical and Enclosure

- Housing ingress protection class IP21, including six (6) IR inspections holes on the LV and HV terminals
- Transformer frame must be of hot dipped galvanized steel
- Gland plates must be removable and of no magnetic material
- All electrical components shall be located 225mm above base of wheels, this to limit damage to transformer in case of water flooding (in basement).

4.4. Name and rating plate

Name plate 200 x 100 mm, black letters on a white background, mounted on the HV- and LV-side of the enclosure. For the text see Data Sheet

The rating plate in accordance with NEN-EN-IEC 60076-11 and including the three-phase schematic drawing of the transformer connections.

One rating plate on the core frame of the transformer and one on the outside of the housing

4.5. Transport facilities

Transformer must be provided with

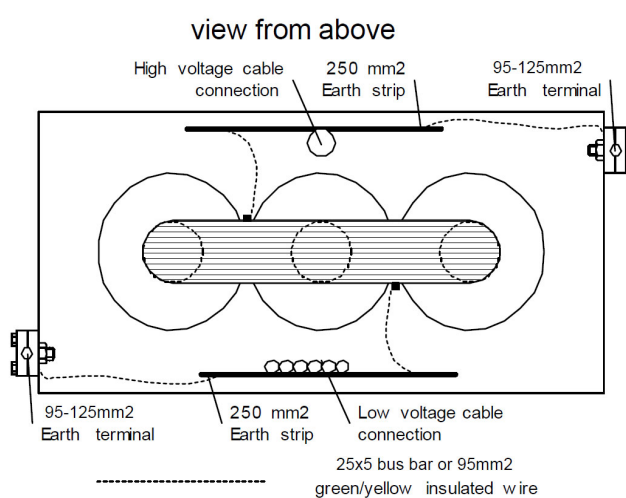
- lifting lugs
- guide rollers (castors) able to rotate 90°
- Locking device for castors

4.6. Earthing facilities

Copper earthing strips, 250 mm² each, for the high and low voltage cable terminations. Position of the strips, top or bottom, depending on the direction of the cables paths.

At the high voltage side, each phase must be provided with an earthing knob with a diameter of 25 mm.

Internal earthing wires 95 mm² see also overview see figure below



4.7. Cable support facilities

Cable supports shall be installed inside the transformer enclosure to enable short circuit proof fixation of the high and low voltage cables. The transformer enclosure shall contain cable entry holes as specified in Data Sheet of the transformer

4.8. Temperature monitoring

Each low-voltage coil must contain two PTC-elements. One with $T_{\text{sense}} 145\text{ }^{\circ}\text{C}$ for alarm purposes and one with $T_{\text{sense}} 155\text{ }^{\circ}\text{C}$ for tripping. The PTC-elements must be connected to a temperature-monitoring device placed in a separate panel. Location of the panel is shown in data sheet. The input voltage of the temperature-monitoring device must be 24-240 V AC/DC.

The temperature-monitoring device must have potential free NC/NO contacts for alarm and tripping. The trip contact must be time delayed for approximately 2 sec. Contact capabilities 5 A and 250 V AC/DC.

Furthermore, transformer must have a dial-type temperature indicator with capillary tube, located in the coil of the centre core. The indicator must be provided with two adjustable contacts.

4.9. Surface treatment

Primers and top layer paintings according to manufacturer's standards.

4.10. Tapping's

Tapping selection must be made by deenergised tap-changers.

5. Requirements for tests

5.1. Factory Acceptance Test

The supplier shall issue the procedures four (4) weeks before the beginning of the Factory Acceptance Test. Signed test certificates have to be provided immediately after the execution of the tests.

Routine tests to be performed according to standard NEN-EN-IEC 60076-11 and all test must be performed with the specified enclosure.

If test fails the transform is rejected.

Additional to the routine tests the following tests are applicable:

- ☐ Partial discharge measurement performed according to section 14.2.7, but must be smaller as specified in section 14.2.7.7,
- ☐ No-load test, also at 110 % of the rated voltage.
- ☐ Lightning impulse test
- ☐ Measurement of sound level

Optional tests, according to NEN-EN-IEC 60076-11.

- ☐ Temperature-rise test. If the transformer is used for convertor applications than the losses caused by harmonics must be included. Calculations to be performed according to NEN-EN-IEC 61378-1.

5.2. Side Acceptance Test

The Transformer will be inspected visually

6. Packaging and transportation

The transformer must be weather protected by closed truck or foil wrappings or other comparable measurements.

7. Documentation and technical data

7.1. To be attached to the offer

Document to be presented during Bidding:

For this type of transformer a **full type tested certificate** according NEN-EN-IEC 60076 must be presented during the bidding including:

- Climate and environmental test
- Fire behaviour test
- Thermal shock

Also technical documentation about:

- ☐ Electrical data
- ☐ No-load losses, load losses, including applicable losses due to harmonics (NEN-EN-IEC 61378-1)
- ☐ Guaranteed temperature rise
- ☐ Guaranteed sound power (Lw) and pressure (Lp) levels (diagram 1 - 2500 Hz)
- ☐ Dimensions and weight
- ☐ Conservation method

7.2. To be delivered one month after award of order

- ☐ Final drawings (in PDF and DWG)
- ☐ Dimension and weights
- ☐ Part lists
- ☐ Manufacturing, inspection and test plan
- ☐ Operation- and maintenance manual

7.3. To be delivered one month after FAT

- ☐ Test report
- ☐ Final drawings in PDF and DWG

8. Ckeck list

8.1. We will check the offers on the following subject

Depending on the application, other weight factors will be used

Subject for immediate rejection if the specification is not met:

- No-load and load losses according ECO Design Directive 2009/125/EC
- Partial discharge max 1 pC above background level and < 5 pC
- Insulation levels
- Full type tested certificate (not older than 5 years)

Subject for evaluation if the specification is not met:

- Rated power
- Rated primary voltage
- Rated secondary voltage
- Short circuit impedance
- Vector group
- Sound pressure level
- No-load losses
- Load losses
- Climatic class code
- Environmental class code
- Fire behaviour class code
- Seismic class no demands accept for crane application
- Insulation thermal class code F, 100 K at rated current (included the harmonic currents)
- Winding construction
- AN cooling
- Dimensions of the transformer
- Housing ingress protection class
- Earthing facilities
- Winding end terminals
- Temperature-monitoring device
- Dial-type temperature indicator

Specific “Data Sheet” :

For each transformer there will be a separate data sheet (A, B, C etc.)

See example on the next page:

1 Data sheet for distribution transformer

checked ☒ alt g geeft selectie en alt n geeft niet selectie

Project information

Project tekst:

For technical and general project information requests regarding this document, please contact:

Project engineer	Name:	--
	Telephone:	--
	E-mail:	--

For commercial information regarding this document, please contact the purchase department:

Purchaser	Name:	--
	Telephone:	--
	E-mail:	--

transformator identification:

TRANSFORMER
T###
#####

1.1 Primary voltage

	<input type="checkbox"/> 3 kV	<input type="checkbox"/> 6 kV	<input type="checkbox"/> 10 kV	Notes
Highest Voltage for equipment Um	7,2 kV	12 kV	17,5 kV	
Vector group other than Dyn5				
Rated primary voltage (principal tapping)	3,15 kV	6,3 kV	10,5 kV	
Primary voltage operating range (Min. - Max.) at principal tapping	2,7 .. 3,3 kV	5,4 - 6,6 kV	8,0 .. 11,0 kV	- 15 % .. + 5 %
Tapping (deenergized switching)	3000	6000	10000	Ca. -5 %
	3075	6150	10250	Ca. -2,5 %
	3150	6300	10500	Principal
	3225	6450	10750	Ca. +2,5 %
	3300	6600	11000	Ca. +5 %

1.2 Secondary voltage

Rated secondary voltage	<input type="checkbox"/> 420 V	<input type="checkbox"/> 525 V	<input type="checkbox"/> 725 V	<input type="checkbox"/> XX V
Highest Voltage for equipment Um	3,6 kV	3,6 kV	3,6 kV	XX kV
Secondary neutral	Solid earthed			

1.3 Rated power

kVA	<input type="checkbox"/> 1000	<input type="checkbox"/> 1250	<input type="checkbox"/> 1600	<input type="checkbox"/> 2500	<input type="checkbox"/> XX
Short circuit impedance	6 %	7,5 %	7,5%	7,5 %	XX %
Guaranteed weighed sound pressure level Lpa at 1 meter	53 dB(A)	54 dB(A)	55 dB(A)	56 dB(A)	XX dB(A)
Power rating	At full load secondary voltage				
Type of load:					
Load with a THD of les then 8% (option A)	<input type="checkbox"/> (Normal distribution according IEC 50160)				
Load with a THD of ca 30% (option B)	<input type="checkbox"/> see 3.2 (Converto transformers according IEC 61378)				

1.4 Maximum dimensions

Length x Width x Height =x.....x.....x mm

For internal transport, horizontal and vertical, the transformers shall be able to fit through the following access/maintenance openings:

- Vertical transport: 3500 x 4000mm (width x length)
- Horizontal transport: 2000 x 2400mm (width x height)

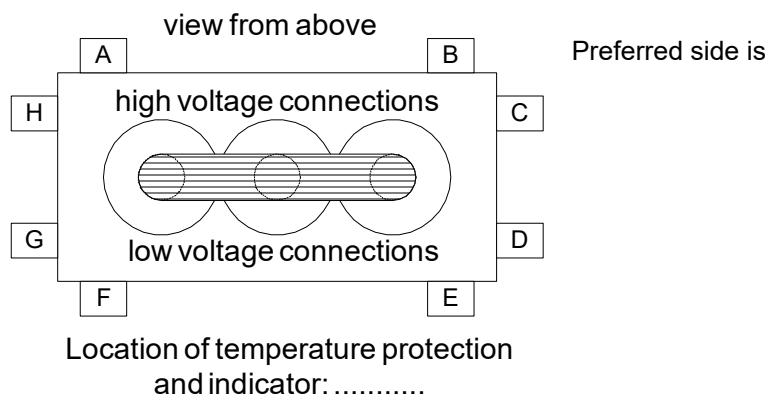
1.5 Cable connection

High voltage cable connection	<input type="checkbox"/> From above	<input type="checkbox"/> From below
Low voltage cable connection	<input type="checkbox"/> From above	<input type="checkbox"/> From below

Number of LV cable	<input type="checkbox"/> 1	<input type="checkbox"/> 2	<input type="checkbox"/> 3	<input type="checkbox"/> 4	<input type="checkbox"/> XX
Distance between the holes	NA	NA	60 mm	60 mm	60 mm

Hole diameter is ca 13-14 mm

1.6 Location of temperature protection / indicator



1.7 Special applications

- Crane application (S-I) ☐ (special requirements added)
- Heavy polluted environment (E5) ☐ (special requirements added)

1.8 Special requirements

- A. -
- B. -